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Data Base for the Development of Improved Temperature Correction Factors for Emissions

Vector Research, Inc.
Ann Arbor, MI

Prepared for

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G. Miller

K. Wilkinson

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This report summarizes work performed by Vector Research, Incorporated, (VRI) to develop a data base describing the efforts of temperature on mobile source emissions. This effort was conducted for the Office of Mobile Source Air Pollution Control (OMSAPC) of the Environmental Protection Agency (EPA) in order to provide data with which OMSAPC can develop improved temperature correction factors for mobile source emissions.

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1.0 INTRODUCTION

This report summarizes work performed by Vector Research, Incorporated, (VRI) to develop a data base describing the effects of temperature on mobile source emissions. This effort was conducted for the Office of Mobile Source Air Pollution Control (OMSAPC) of the Environmental Protection Agency (EPA) in order to provide data with which OMSAPC can develop improved temperature correction factors for mobile source emissions. The effort involved the following steps:

(1) gathering of available data from various sources,

(2) development of a common format for the data,

(3) transformation of the data to machine-readable form, and

(4) reformatting of the data into the common format.

The purpose of this report is to provide information in abstract form for each of the sources which contributed to the data base. A total of nine sources were used, and the remaining nine sections of this report provide the following information concerning each of the sources in turn:

(1) organization which produced the data base,

(2) purpose for producing the data base,

(3) vehicles used,

(4) location of the testing effort,

(5) dates of the testing effort,

(6) test conditions,

(7) quantity of available data,

(8) sources of test vehicles,

(9) maintenance which was performed prior to testing the vehicles,

(10) whether the data are replicates of another testing effort, and

(11) any other important information concerning the data or the source.

The data base format has been transmitted separately to OMSAPC and is available from that office.

2.0 CHICAGO COLD TEST DATA

Organization: Automotive Testing Laboratories for EPA

Purpose: To provide paired test results on each vehicle (low ambient temperature and normal laboratory temperature).

Vehicles Used: In-use vehicles were selected from vehicles used in FY77 Emission Factor Program. A total of 84 vehicles were used from model years 1972 through 1977. All vehicles were built under Federal emission standards.

Location: Chicago, Illinois

Dates: January through March 1978

Test Conditions: Federal Test Procedure (but at low ambient temperature with commercial fuel), followed by Highway Fuel Economy Test (HFET), Federal Three-Mode Test, Federal Short Cycle, and Two-Speed Idle Test. One set of tests was conducted on each vehicle at ambient temperatures ranging from 16^{o} F to 57^{o} F.

Amount of Data: One low-temperature set of tests for each vehicle.

Sources of Test Vehicles: A subset of vehicles from Emission Factor Program (obtained from randomly-selected local residents).

Maintenance: None

Replicates of Another Study: No

Other Information:

- Data base identification code[1] is CH1.
- See [Heinmiller, 1978].
- A separate set of tests was conducted on each of these vehicles at normal laboratory temperatures (in order to provide paired test results on each vehicle), but these tests are not included in this data base.

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[1]These codes are used to identify the data source on each record of the data base.

3.0 CO HOT SPOT DATA

Organization: EPA

Purpose: To generate preliminary data on the effect on CO emission test results of soak time prior to the Federal Test Procedure (FTP), soak temperature prior to the FTP, and alternate driving cycles.

Vehicles Used: Five test vehicles, model years 1970 and 1976. All vehicles were built under Federal emission standards.

Location: Ann Arbor, Michigan

Dates: December 1976 to February 1977

Test Conditions: LA-4 and New York City (NYC) S-8 driving cycles were used. Tests followed varying soak times at varying temperatures. Soak times included overnight (16 to 20 hours), 4 hours, 2 hours, 1 hour, 10 minutes, and 1 minute. Soak temperatures included outside ambient temperatures ranging from approximately 10^{o} F to approximately 25^{o} F, and inside cell temperatures of about 77^{o} F.

Amount of Data: Approximately 24 tests per vehicle, half LA-4 and half NYC cycles.

Sources of Test Vehicles: Unknown

Maintenance: Unknown

Replicates of Another Study: No

Other Information:

- Data base identification code is AA1.
- See [Hutchins, et al., 1977].
- This portion of the data base includes some bad data (see comment records), and some test results are missing.

4.0 GULF DATA

Organization: Gulf Science and Technology Company for EPA

Purpose: To determine the effect of ambient temperature on emissions and fuel economy.

Vehicles Used: Thirteen vehicles, most 1977 and 1978 model years, but two were pre-1975 and two were 1980 prototypes. Nine of the vehicles were built under Federal emission standards, while four were built under California standards.

Location: Harmerville, Pennsylvania

Dates: 1977 to 1979

Test Conditions: Modified cold start FTP at ambient temperatures of 0, 20, 40, 60, 70, 80, 90 and 110° F. The FTP was followed by:

(1) HFET,
(2) Sulfate Emission Tests (at 0, 40, 80, and 110° F),
(3) Federal Short Cycle (for first six vehicles, at 0, 40, 80, and 110° F),
(4) Federal Three Mode (for first six vehicles, at 0, 40, 80, and 110° F), and
(5) New York City cycle (for remaining vehicles, at 0, 40, 80, and 110° F).

Emissions were recorded for many unregulated pollutants as well as for HC, CO, NO_x, and CO_2.

Amount of Data: Approximately 18 sets of tests for each of the 13 vehicles. (Duplicate tests were generally run at each temperature, and higher-temperature tests were performed both with and without vehicle air conditioners in operation.)

Sources of Test Vehicles: Obtained locally from employees or rental agencies, or purchased new.

Maintenance: New cars were operated under normal driving conditions for approximately 4000 miles before testing. All cars were tuned up before testing.

Replicates of Another Study: No.

Other Information:

- Data base identification code is GU1.
- See [Spindt, et al., 1979].

5.0 1975 CANADIAN DATA

Organization: Mobile Sources Division, Fisheries and Environment Canada, Environmental Protection Service

Purpose: Comparison of alternative emission control technologies under Canadian conditions

Vehicles Used: Thirteen 1974 and 1975 model year vehicles. Three of these vehicles were manufactured under US Federal emission standards, five were built under California standards, and five were built to meet Canadian standards.

Location: Canada

Dates: 1975 through 1976

Test Conditions: FTP was used and tests were conducted at multiple ambient temperatures ranging between -30^{o} C and $+30^{o}$ C. Idle CO measurements were taken in about 15 percent of the tests and idle HC measurements were taken in a very few of the tests.

Amount of Data: Approximately 50 tests were conducted on each vehicle.

Sources of Test Vehicles: Standard production vehicles.

Maintenance: Vehicle inspection was performed according to the manufacturer's maintenance timetable.

Replicates of Another Study: No

Other Information:

- Data base identification code is CA1.
- See [Ostroūchov, 1978].

6.0 1978 CANADIAN DATA

Organization: Mobile Sources Division, Environment Canada, Environmental Protection Service.

Purpose: Comparison of alterative emission control technologies under Canadian conditions.

Vehicles Used: Eight 1977 model year vehicles. Three of these vehicles were manufactured under US Federal emission standards, two were built under California standards, and three were built to meet Canadian standards.

Location: Canada

Dates: 1978

Test Conditions: FTP was used and tests were conducted at multiple ambient temperatures ranging between -21° C and +29° C. Idle HC and CO measurements were also generally taken.

Amount of Data: Approximately 25 tests were conducted on each vehicle.

Sources of Test Vehicles: Standard production vehicles.

Maintenance: Vehicles were kept tuned to manufacturers' specifications.

Replicates of Another Study: No

Other Information:

- Data base identification code is CA2.
- See [Ostrouchov, 1979].

7.0 CANADIAN DATA -- HAYDEN PAPER

Organization: Oakville Research Centre, Shell Canada Limited, for Canadian Combustion Research Laboratory

Purpose: Comparison of alternative emission control technologies under Canadian conditions.

Vehicles Used: Eleven 1976 to 1978 model year vehicles. All vehicles were built under Canadian emission standards.

Location: Canada

Dates: 1977 to 1978

Test Conditions: FTP and HWFET conducted after a 12-hour soak period at the test temperature. Test temperatures used were 21, 4, -12, and -23^{o} C.

Amount of Data: A single set of results reported for each vehicle at each temperature.

Sources of Test Vehicles: Probably purchased new.

Maintenance: Unknown. Vehicles were broken in for at least 8000km in combined urban and highway driving before testing.

Replicates of Another Study: No

Other Information:

- Data base identification code is CA3.
- See [Hayden, 1978].
- All reported results are averages of two or more tests.

8.0 BUREAU OF MINES DATA

Organization: Fuels Combustion Research Group, Bartlesville Energy Research Center for EPA

Purpose: To study the effects of ambient temperature on exhaust emissions.

Vehicles Used: Thirty vehicles, from 1967 through 1975 model years. (1975 vehicles were prototypes, others were production cars.) All vehicles were built under Federal emission standards.

Location: Bartlesville, Oklahoma

Dates: 1974

Test Conditions: Used FTP, but with modifications to vehicle cooling procedure to approximate in-use conditions. Each vehicle was tested at multiple ambient temperatures. Temperatures used included 20, 50, 60, 70, 75, 80, 90, and 110^{o} F. Aldehyde emissions were recorded in addition to emissions for the regulated pollutants.

Amount of Data: Each vehicle was tested at four temperatures. At highest temperature vehicles were tested with and without the vehicle air conditioner operating.

Sources of Test Vehicles: Prototypes were obtained from manufacturers; production vehicles were obtained from dealers' lots.

Maintenance: Vehicles were inspected and, if necessary, tuned before testing.

Replicates of Another Study: No.

Other Information:

- Data base identification code is BM1.
- See [Eccleston, et al., 1974 and Eccleston, et al., 1975].
- Most reported results are averages of duplicate tests.

9.0 METHANOL EXPERIMENTS

Organization: Energy Research and Development Administration's Bartlesville Energy Research Centre

Purpose: To determine the emission and fuel-economy characteristics of methanol and methanol/gasoline blends as automotive fuel.

Vehicles Used: Ten vehicles used for emissions measurements; all were 1974 and 1975 model year cars. All vehicles were manufactured to meet Federal emission standards.

Location: Bartlesville, Oklahoma

Dates: 1975

Test Conditions: FTP and HWFE tests were used. Tests were conducted at 20, 75, and 100° F. Aldehyde emissions were recorded in addition to emissions for the regulated pollutants.

Amount of Data: Usable data (i.e., data from tests using non-methanol fuel) consist of 45 reported sets of results for varying combinations of vehicle, temperature, and fuel type (indolene and commercial fuel).

Sources of Test Vehicles: Most were purchased new; two 1974 model year vehicles had been previously driven about 10,000 miles.

Maintenance: New vehicles were broken in for 2,500 miles, using city and highway driving. Before testing, deposits were cleaned from combustion chamber surfaces and vehicles were adjusted to within manufacturers' specifications.

Replicates of Another Study: No.

Other Information:

- Data base identification code is BM2.
- See [Allsup, undated].

10.0 DEPARTMENT OF ENERGY DATA

Organization: Bartlesville Energy Research Center, Department of Energy

Purpose: To investigate cold start fuel economy as a function of ambient temperature.

Vehicles Used: Four 1977 model year vehicles, all of which were manufactured to meet Federal emission standards.

Location: Bartlesville, Oklahoma

Dates: 1977

Test Conditions: FTP and HWFE tests were used. Two back-to-back fuel economy tests were used (referred to as HWFE "warm-up" and HWFE "test"). Tests were performed at 20, 45, 70 and 100^{o} F.

Amount of Data: One set of results reported for each combination of vehicle and temperature.

Sources of Test Vehicles: Leased.

Maintenance: Vehicles were tuned to manufacturer specifications before testing.

Replicates of Another Study: No.

Other Information:

- Data base identification code is BM3.
- See [DOE, 1977].
- Reported results are averages of triplicate tests.

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